

WHAT IS CLAIMED IS:

1. In a method for the preparation of a semiconductor device by forming a patterned resist layer on the surface of a substrate by pattern-wise light-exposure of a photoresist layer of a chemical-amplification positive-working photoresist composition comprising (A) a compound capable of generating an acid by irradiation with actinic rays and (B) a resinous compound capable of being imparted with increased solubility in an aqueous alkaline solution in the presence of an acid, the improvement which comprises decreasing the number of defects in the patterned resist layer by using a photoresist composition of which a layer before the pattern-wise light-exposure exhibits reduction of thickness at 23 °C in a 2.38% by weight aqueous solution of tetramethylammonium hydroxide at a rate in the range from 0.09 to 1.0 nm/second.

2. The improvement as claimed in claim 1 in which the resinous compound as the component (B) of the photoresist composition is a copolymeric resin (B-1) comprising monomeric units of hydroxystyrene or α -methyl hydroxystyrene substituted by acid-dissociable groups for the hydrogen atoms of the hydroxyl groups and monomeric units of hydroxystyrene or α -methyl hydroxystyrene.

3. The improvement as claimed in claim 2 in which the acid-dissociable group is selected from the group consisting of tertiary alkyloxycarbonyl groups, tertiary alkyloxycarbonylalkyl groups, tertiary alkyl groups, cyclic ether groups and alkoxyalkyl groups.

4. The improvement as claimed in claim 3 in which the acid-dissociable group is selected from the group consisting of tert-butyloxycarbonyl group, tert-butyloxycarbonylmethyl group, tert-butyl group, tetrahydropyranyl group, tetrahydrofuran group, 1-ethoxyethyl group and 1-methoxypropyl group.

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5. The improvement as claimed in claim 2 in which the molar fraction of the monomeric units of hydroxystyrene or α -methyl hydroxystyrene substituted by acid-dissociable groups for the hydrogen atoms of the hydroxyl groups in the copolymeric resin (B-1) is in the range from 10 to 60%.

6. The improvement as claimed in claim 1 in which the component (B) is a combination of a first resinous compound (B₁) which is a polyhydroxystyrene having a weight-average molecular weight of 3000 to 30000 with a molecular weight dispersion of 1 to 6.0 and substituted by tert-butyloxycarbonyl groups or tetrahydropyranyl groups for 10 to 50% of the hydrogen atoms of the hydroxyl groups and a second resinous compound (B₂) which is a polyhydroxystyrene having a weight-average molecular weight of 3000 to 30000 with a molecular weight dispersion of 1 to 6.0 and substituted by alkoxyalkyl groups for 10 to 50% of the hydrogen atoms of the hydroxyl groups.

7. The improvement as claimed in claim 6 in which the weight proportion of the first resinous compound (B₁) and the second resinous compound (B₂) is in the range from 10:90 to 90:10.

8. The improvement as claimed in claim 1 in which the resinous compound as the component (B) of the photoresist composition is a copolymeric resin (B-2) comprising monomeric units of acrylic acid or methacrylic acid substituted by tertiary alkyl groups for the hydrogen atoms of the carboxyl groups and monomeric units of hydroxystyrene or α -methyl hydroxystyrene.

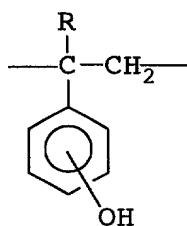
9. The improvement as claimed in claim 8 in which the tertiary alkyl group is an alkyl-substituted monocyclic or polycyclic hydrocarbon group.

10. The improvement as claimed in claim 9 in which the alkyl-substituted monocyclic or polycyclic group is a 1-alkyl cycloalkyl group or a 2-alkyl adamantly group.

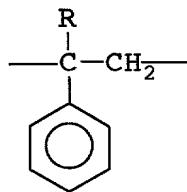
11. The improvement as claimed in claim 8 in which the copolymeric resin (B-2) further comprises monomeric units of styrene.

12. The improvement as claimed in claim 8 in which the copolymeric resin (B-2) further comprises at least two monomeric units of acrylic acid or methacrylic acid each substituted by an acid-dissociable crosslinking group for the hydrogen atom of the carboxyl group per molecule.

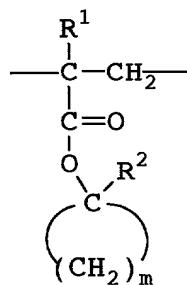
13. The improvement as claimed in claim 8 in which the copolymeric resin (B-2) consists of (b1) monomeric units of a first type represented by the general formula



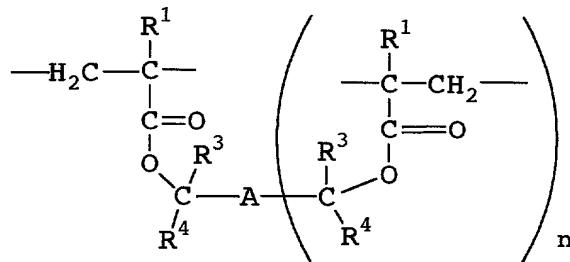
in which R is a hydrogen atom or a methyl group, (b2) monomeric units of a second type represented by the general formula



in which R has the same meaning as defined above, (b3) monomeric units of a third type represented by the general formula



in which R^1 is a hydrogen atom or a methyl group, R^2 is an alkyl group having 1 to 5 carbon atoms and the subscript m is an integer in the range from 3 to 7, and (b4) monomeric units of a fourth type represented by the general formula



in which R^1 has the same meaning as defined above, R^3 and R^4 are each an alkyl group having 1 to 5 carbon atoms, the subscript n is 1, 2 or 3 and A is a single bond or an organic residue of $(n+1)$ valency.

14. The improvement as claimed in claim 13 in which R^2 in the general formula representing the monomeric units (b3) is an ethyl group.

15. The improvement as claimed in claim 13 in which, in the general formula representing the monomeric units (b4), the subscript n is 1 and A is a straightly linear or branched alkylene group or a partially or totally cyclized alkylene group.

16. The improvement as claimed in claim 13 in which, in the general formula representing the monomeric units (b4), the subscript n is 1, A is a straightly linear alkylene group having 2 to 10 carbon atoms and R^3 and R^4 are each a methyl group.

17. The improvement as claimed in claim 13 in which the molar fractions of the monomeric units (b1), (b2), (b3) and (b4) are in the ranges of from 50 to 80%, from 1 to 25%, from 3 to 25% and from 1 to 15%, respectively.

18. The improvement as claimed in claim 1 in which, the photoresist composition further comprises (C) an aliphatic tertiary amine compound, (D) a carboxylic acid compound, a phosphorus-containing oxoacids or an ester thereof or a combination of (C) and (D), the amount of each of the component (C) and component (D) being in the range from 0.01 to 1.0 part by weight per 100 parts by weight of the component (B).

19. The improvement as claimed in claim 18 in which the component (D) is salicylic acid or phenylphosphonic acid.

20. The improvement as claimed in claim 1 in which the semiconductor device has a contact hole in the resist layer.